

FACT SHEET AND SUPPLEMENTAL INFORMATION
FOR THE PROPOSED REISSUANCE OF
THE NPDES GENERAL PERMIT FOR NEW AND EXISTING SOURCES
IN THE OFFSHORE SUBCATEGORY OF
THE OIL AND GAS EXTRACTION POINT SOURCE CATEGORY FOR
THE WESTERN PORTION OF THE OUTER CONTINENTAL SHELF OF
THE GULF OF MEXICO (GMG290000)

December 12, 2006

U.S. Environmental Protection Agency
Region 6
1445 Ross Ave.
Dallas, TX 75202

This page is intentionally left blank.

Proposed Reissuance of the NPDES General Permit for New and Existing Sources in the Offshore Subcategory of the Oil and Gas Extraction Point Source Category for the Western Portion of the Outer Continental Shelf of the Gulf of Mexico (GMG290000)

AGENCY: Environmental Protection Agency

ACTION: Notice of Proposed NPDES General Permit Issuance

SUMMARY: The Regional Administrator of Region 6 today proposes to reissue the National Pollutant Discharge Elimination System (NPDES) general permit No. GMG290000 for existing source and New Source facilities in the Offshore Subcategory of the Oil and Gas Extraction Point Source Category (40 CFR Part 435, Subpart A), located in and discharging to the Outer Continental Shelf offshore of Louisiana and Texas. The discharge of produced water to that portion of the Outer Continental Shelf from Offshore Subcategory facilities located in the territorial seas of Louisiana and Texas is also authorized by this permit.

The draft permit proposes to retain the limitations and conditions of the expiring permit. The existing permit limitations conform with the Oil and Gas Offshore Subcategory Guidelines and contain additional requirements to assess impacts from the discharge of produced water to the marine environment, as required by section 403(c) of the Clean Water Act.

The following changes to the expiring permit are proposed as part of the permit reissuance. Requirements to comply with new cooling water intake structure regulations are included. Sub-lethal effects are required to be measured for whole effluent toxicity testing. New test methods are allowed for monitoring cadmium and mercury in stock barite. Clarifications have been added to the permit requirements for: types of activities covered; pit cleaning and other wash water; end of well monitoring; sediment toxicity test averaging; the drilling fluids discharge rate limitation; discharges associated with dual gradient drilling; toxicity testing for miscellaneous discharges; and calculation of the produced water critical dilution for toxicity testing. Other minor changes in wording are also proposed to clarify EPA's intent regarding the permit's requirements.

ADDRESS: Comments should be sent to:

Ms. Diane Smith
Water Quality Protection Division
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202-2733.

DATE: Comments must be received by [30 days after publication].

FOR FURTHER INFORMATION CONTACT: Ms. Diane Smith, U.S. Environmental

Protection Agency, Region 6, 1445 Ross Avenue, Dallas, Texas 75202-2733. Telephone: (214) 655-7191. The complete proposed permit, Fact Sheet and a copy of the Federal Register notice may also be obtained on the Internet at: <http://www.epa.gov/earth1r6/6wq/6wq.htm>

FACT SHEET AND SUPPLEMENTAL INFORMATION

Table of Contents

- I. Legal Basis
- II. Ocean Discharge Criteria Evaluation
- III. Regulatory Background
- IV. Facility Coverage
- V. Types of Discharges Covered
- VI. Specific Permit Conditions
 - A. Drilling Fluids and
 - B. Drill Cuttings
 - C. Produced Water
 - D. Produced Sand
 - E. Well treatment, completion fluids and workover fluids
 - F. Deck Drainage
 - G. Sanitary waste
 - H. Domestic waste
 - I. Miscellaneous discharges
 - J. All Discharges
- VII. Produced Water Study for the Northern Gulf of Mexico
 - A. Causes and Effects of the Northern Gulf of Mexico Hypoxia
 - B. Produced Water Discharges to the Hypoxic Zone
 - C. Study on the Impact of Produced Water on the Hypoxic Zone of the Northern Gulf of Mexico
- VIII. Changes from the Expiring Permit
 - A. Cooling Water Intake Requirements - 316(b) Phase III
 - B. Use of Sub-lethal Effects in Whole Effluent Toxicity Compliance
 - C. Clarification of Types of Activities Covered
 - D. Discharges Associated with Pit Cleaning and Other Wash Water
 - E. Discharge of Wastes from Surface Preparation of Coating
 - F. End-of-Well Monitoring for Non-Aqueous Based Drilling Fluids
 - G. Sediment Toxicity Test Averaging
 - H. Drilling Fluid Discharge Rate Limitation
 - I. Application of Free Oil limits Prior to Installation of Marine Risers
 - J. Discharges Associated with Dual Gradient Drilling
 - K. Toxicity Testing Requirements for Miscellaneous Discharges
 - L. Produced Water Oil and Grease Sampling
 - M. Calculation of Produced Water Critical Dilution
 - N. Measurement of Cadmium and Mercury in Stock Barite
 - O. Previous Study Requirements
- IX. References

I. Legal Basis

Section 301(a) of the Clean Water Act (CWA or the Act), 33 USC 1311(a), renders it unlawful to discharge pollutants to waters of the United States in the absence of authorizing permits. CWA section 402, 33 U.S.C. section 1342, authorizes EPA to issue National Pollutant Discharge Elimination System (NPDES) permits allowing discharges on the condition they will meet certain requirements, including CWA sections 301, 304, 306, 401 and 403. Those statutory provisions require NPDES permits include effluent limitations for authorized discharges that: (1) meet standards reflecting levels of technological capability; (2) comply with EPA-approved state water quality standards; (3) comply with other state requirements adopted under authority retained by states under CWA section 510, 33 U.S.C. section 1370; and, (4) cause no unreasonable degradation to the territorial seas, waters of the contiguous zone, or the oceans.

CWA section 301 requires compliance with "best conventional pollution control technology" (BCT) and "best available pollution control technology economically achievable" (BAT) no later than March 31, 1989. CWA section 306 requires compliance with New Source Performance Standards (NSPS) no later than the effective date of such standards. Accordingly, three types of technology-based effluent limitations are included in the proposed permit. With regard to conventional pollutants, i.e., pH, BOD, oil and grease, TSS, and fecal coliform, CWA section 301(b)(1)(E) requires effluent limitations based on BCT. With regard to nonconventional and toxic pollutants, CWA sections 301(b)(2)(A), (C), and (D) require effluent limitations based on BAT. For New Sources, CWA section 306 requires effluent limitations based on New Source Performance Standards (NSPS). Final effluent guidelines specifying BCT, BAT, and NSPS for the Offshore Subcategory of the Oil and Gas Point Source Category (40 CFR 435, Subpart A) were issued January 15, 1993, and were published at 58 FR 12454 on March 4, 1993. Those guidelines were modified on January 22, 2001 (see 66 FR 6850, January 22, 2001), to issue technology based treatment standards for discharges associated with the industry's use of synthetic based drilling fluids.

II. Ocean Discharge Criteria Evaluation.

When issuing permits for discharges into waters of the territorial sea, contiguous zone, or oceans, CWA section 403 requires EPA to consider guidelines for determining potential degradation of the marine environment. These Ocean Discharge Criteria (40 CFR 125, Subpart M) are intended to "prevent unreasonable degradation of the marine environment and to authorize imposition of effluent limitations, including a prohibition of discharge, if necessary, to ensure this goal" (see 45 FR 65942, October 3, 1980). EPA Region 6 has previously determined that discharges in compliance with the Western Gulf of Mexico Outer Continental Shelf general permit (GMG290000) will not cause unreasonable degradation of the marine environment (see 57 FR 54642, November 19, 1992, 64 FR 19156, April 19, 1999, 66 FR 65209, December 18, 2001, and 69 FR 60150, October 7, 2004). This proposed permit is no less stringent than those previous permits and contains additional limitations which will protect water quality and reduce the discharge of toxic pollutants to the marine environment. Therefore, the Region finds that discharges proposed to be authorized by the reissued general permit will not cause unreasonable

degradation of the marine environment.

In addition to conditions intended to ensure compliance with Ocean Discharge Criteria, the current permit contains data gathering requirements for platforms discharging produced water to the hypoxic zone of the northern Gulf of Mexico. As described later in this Fact Sheet, EPA conducted an analysis of the produced water data collected by Industry to determine whether there is the potential for produced water discharges to contribute to the hypoxia. The results of that study show that the existing produced water discharges do not have the potential to unreasonably degrade the marine environment. Therefore, EPA has determined that produced water which is discharged to the hypoxic zone also comply with Ocean Discharge Criteria.

III. Regulatory Background

On April 3, 1981 (see 46 FR 20284), EPA published three final general NPDES permits authorizing discharges from facilities in the Offshore Subcategory of the Oil and Gas Extraction Point Source Category located offshore of Louisiana and Texas. Two of those permits, TX0085651 and LA0060224, authorized discharges from facilities located in the territorial seas off Louisiana and Texas. The third permit, TX0085642, authorized discharges from facilities located seaward of the outer boundary of the territorial seas off Louisiana and Texas, an area commonly known as the Outer Continental Shelf. The Outer Continental Shelf General Permit did not include several facilities located near the Flower Garden Banks, an area with sensitive biological features approximately 120 miles southeast of Galveston, Texas. Twelve facilities in the vicinity of the Flower Garden Banks were authorized to discharge under individual permits. The 1981 general permits implemented "Best Practicable Control Technology Currently Available" (BPT), as established by effluent guidelines for the Offshore Subcategory (see 40 CFR 435). Those permits contained a daily maximum oil and grease limit of 72 mg/l for produced water discharges, a prohibition of the discharge of oil based drilling fluids, a limit of no free oil for drilling fluids, drill cuttings, deck drainage and well treatment fluids, and 1 mg/l residual chlorine for sanitary waste water.

The permits expired April 3, 1983, and were reissued on September 15, 1983 (48 FR 41494), with an expiration date of June 30, 1984. The permits were issued for a short period of time because promulgation of National Effluent Limitations Guidelines for Best Available Technology Economically Achievable were expected by 1983 and again by 1984. The limitations contained in the permits were unchanged in the 1984 reissuance; however, some changes were made for facilities located near the Flower Garden Banks. Lease blocks of: North Padre Island 962 and Garden Banks 113 through 132, previously excluded from the permit, were authorized to discharge. High Island South block A392 was excluded from the permit due to its potential effects on the Flower Garden Banks ecosystem. The Louisiana Territorial Seas General Permit was reissued on November 7, 1997 (62 FR 59687), and renumbered as LAG260000. The Texas Territorial Seas General Permit was reissued on September 6, 2005, as permit number TXG260000.

On July 9, 1986 (51 FR 24897), EPA reissued the Outer Continental Shelf General

Permit. In that action EPA Region 6 issued a joint permit with Region 4 authorizing discharges from facilities located in the Outer Continental Shelf throughout the Gulf of Mexico. That permit, numbered GMG280000, prohibited discharge of oil based drilling fluids, oil contaminated drilling fluids, drilling fluids containing diesel oil, and drill cuttings generated using oil based drilling fluids. New limits were included in the permit for suspended particulate phase toxicity in drilling fluids, the drilling fluid discharge rate near areas of biological concern, and for free oil in drilling fluids and drill cuttings. The general permit expired on July 1, 1991.

On November 19, 1992, EPA Region 6 reissued the NPDES general permit for the Western Gulf of Mexico Outer Continental Shelf (57 FR 54642), GMG290000, covering operators of lease blocks in the Offshore Subcategory of the Oil and gas Extraction Point Source Category located seaward of the outer boundary of the territorial seas of Texas and Louisiana. As a part of that reissuance, new limits for produced water toxicity were added, as well as new limits for cadmium and mercury in stock barite, and a prohibition on the discharge of drilling fluids to which mineral oil has been added. That general permit was modified on December 3, 1993, to implement Offshore subcategory effluent limitations guidelines promulgated March 4, 1993 (58 FR 12504), and to include more accurate calculations of produced water critical dilutions. A general permit covering New Sources in that same area of coverage was issued and combined with the Western Gulf of Mexico Outer Continental Shelf general permit on August 9, 1996 (61 FR 41609). The permit expired on November 19, 1997, and was reissued in two parts on November 2, 1998 (63 FR 58722), and April 19, 1999 (64 FR 19156).

In the 1998 reissuance, EPA Region 6 authorized new discharges of seawater and freshwater to which treatment chemicals, such as biocides and corrosion inhibitors, have been added. The maximum discharge rate limit for produced water was removed and the critical dilutions required to be met for the produced water toxicity limit were updated based on the new discharge rates and more current models. To account for advances in drilling fluid technology, the permit was modified on December 18, 2001 (66 FR 65209), to authorize discharges associated with the use of synthetic based drilling fluids. Additional monitoring requirements were also included at that time to address hydrostatic testing of existing piping and pipelines and those discharges were authorized. That permit expired on November 3, 2003, and was reissued on October 7, 2004 (69 FR 60150). With that reissuance, EPA made the following changes to the permit. Produced water monitoring requirements were included for facilities located in the hypoxic zone. The discharge prohibitions at National Marine Sanctuaries were clarified in an attempt to better reflect National Oceanic and Atmospheric Administration regulations. See 15 C.F.R. Part 922.. The variability factor for use in determining compliance with the permit's limits for sediment toxicity and biodegradation was removed. An allowance was included for blending of compliant synthetic base fluids in drilling fluids. The requirement to submit fourteen day advanced notification of intent to be covered by the permit is removed. The final discharge monitoring report will be required to be submitted along with the notice of termination. Clarifications were made in the definition of minor miscellaneous discharges to better represent deep water technologies. Other clarifications were made to the permit's miscellaneous discharge requirements to show that toxicity testing is not required for non-toxic dyes. The toxicity limit for sub sea fluids was decreased from 200 mg/l to 50 mg/l. The permit was issued for a three

year term rather than the typical five year term so that the results from the produced water hypoxia study could be addressed in a timely manner if additional permit conditions were found to be warranted.

IV. Facility Coverage

The general permit covers existing source facilities and new source facilities in the Offshore Subcategory of the Oil and Gas Extraction Point Source Category located in and discharging to lease blocks in the Outer Continental Shelf of the Western Gulf of Mexico. The permit also authorizes discharges to the Outer Continental Shelf of the Western Gulf of Mexico from facilities located in the territorial seas offshore of Louisiana and Texas. Operators with platforms located near the boundary of the territorial seas are allowed to transfer waste water from a platform within the territorial seas to a platform located in the Outer Continental Shelf for discharge. This does not, however, include drilling fluids or drill cuttings from facilities where the wellhead is located in the territorial seas. Those discharges are prohibited in the territorial seas based on Offshore Subcategory effluent limitations guidelines, and thus are not authorized to be transferred to the Outer Continental Shelf and discharged.

V. Types of Discharges Covered

The discharges proposed to be authorized by the reissued permit are listed below. Changes from the previous permit generally include minor clarifications for existing discharges. The definitions of the waste streams are the same as those given in the Offshore Subcategory guidelines (40 CFR 435, Subpart A) except for miscellaneous discharges which were not covered by those guidelines. The waste streams specifically are:

A. Drilling fluids - the circulating fluid (mud) used in the rotary drilling of wells to clean and condition the hole and to counterbalance formation pressure. Classes of drilling fluids are:

(a) “Water-Based Drilling Fluid” means the continuous phase and suspending medium for solids is a water-miscible fluid, regardless of the presence of oil.

(b) “Non-Aqueous Drilling Fluid” means the continuous phase and suspending medium for solids is a water-immiscible fluid, such as oleaginous materials (*e.g.*, mineral oil, enhanced mineral oil, paraffinic oil, C₁₆-C₁₈ internal olefins, and C₈-C₁₆ fatty acid/2-ethylhexyl esters).

(i) “Oil-Based” means the continuous phase of the drilling fluid consists of diesel oil, mineral oil, or some other oil, but contains no synthetic material or enhanced mineral oil.

(ii) “Enhanced Mineral Oil-Based” means the continuous phase of the drilling fluid is enhanced mineral oil.

(iii) “Synthetic-Based” means the continuous phase of the drilling fluid is a synthetic material or a combination of synthetic materials.

B. Drill cuttings - the particles generated by drilling into subsurface geologic formations including cured cement carried out from the wellbore with the drilling fluid. Examples of drill cuttings include small pieces of rock varying in size and texture from fine silt to gravel. Drill cuttings are generally generated from solids control equipment and settle out and accumulate in quiescent areas in the solids control equipment or other equipment processing drilling fluid (*i.e.*, accumulated solids).

(a) “Wet Drill Cuttings” means the unaltered drill cuttings and adhering drilling fluid and formation oil carried out from the wellbore with the drilling fluid.

(b) “Dry Drill Cuttings” means the residue remaining in the retort vessel after completing the retort procedure specified in Appendix 7 of 40 CFR 435, Subpart A.

C. Deck drainage - any waste resulting from deck washings, spillage, rainwater, and runoff from gutters and drains including drip pans and work areas within facilities subject to this permit.

D. Produced water - the water (brine) brought up from the hydrocarbon-bearing strata during the extraction of oil and gas, and can include formation water, injection water, and any chemicals added downhole or during the oil/water separation process.

E. Produced sand - slurried particles used in hydraulic fracturing, the accumulated formation sands, and scale particles generated during production. Produced sand also includes desander discharge from produced water waste stream and blowdown of water phase from the produced water treating system.

F. Well treatment, completion fluids and workover fluids - well treatment fluids are any fluids used to restore or improve productivity by chemically or physically altering hydrocarbon-bearing strata after a well has been drilled, well completion fluids are salt solutions, weighted brines, polymers, and various additives used to prevent damage to the well bore during operations which prepare the drilled well for hydrocarbon production, and workover fluids are salt solutions, weighted brines, polymers, or other specialty additives used in a producing well to allow for maintenance, repair or abandonment procedures.

G. Sanitary waste - human body waste discharged from toilets and urinals.

H. Domestic waste - material discharged from galleys, sinks, showers, safety showers, eye wash stations, hand washing stations, fish cleaning stations, and laundries.

I. Miscellaneous discharges -

desalinization unit discharge - wastewater associated with the process of creating freshwater from seawater.

blowout preventer control fluid - fluid used to actuate the hydraulic equipment on the blow-out preventer.

uncontaminated ballast/bilge water - seawater added or removed to maintain proper draft.

uncontaminated freshwater - freshwater which is discharged without the addition of chemicals; included are: (1) discharges of excess freshwater that permit the continuous operation of fire control and utility lift pumps; (2) excess freshwater from pressure maintenance and secondary recovery projects; (3) water used during training and testing of personnel in fire protection; and (4) water used to pressure test new piping.

mud, cuttings and cement at the sea floor - discharges that occur at the seafloor prior to installation of the marine riser and during marine riser disconnect, well abandonment and plugging operations.

uncontaminated seawater - seawater which is returned to the sea without the addition of chemicals. Included are: (1) discharges of excess seawater which permit the continuous operation of fire control and utility lift pumps; (2) excess seawater from pressure maintenance and secondary recovery projects; (3) water released during the training and testing of personnel in fire protection; (4) seawater used to pressure test piping; and (5) once through noncontact cooling water which has not been treated with biocides.

boiler blowdown - discharges from boilers necessary to minimize solids build-up in the boilers, including vents from boilers and other heating systems.

source water and source sand - water from non-hydrocarbon bearing formations for the purpose of pressure maintenance or secondary recovery including the entrained solids.

diatomaceous earth filter media - filter media used to filter seawater or other authorized completion fluids and subsequently washed from the filter.

excess cement slurry - the excess mixed cement, including additives and wastes from equipment washdown, after a cementing operation.

Subsea production discharges - include: subsea wellhead preservation fluids, subsea production control fluid, hydrate control fluid, umbilical steel tube storage fluid, leak tracer fluid, and riser tensioner fluids.

J. Chemically Treated Seawater and Freshwater - seawater or freshwater to which corrosion inhibitors, scale inhibitors, and/or biocides have been added and includes the following discharges:

1. Excess seawater which permits the continuous operation of fire control and utility lift pumps;
2. Excess seawater from pressure maintenance and secondary recovery projects;
3. Water released during training of personnel in fire protection;
4. Seawater used to pressure test piping and pipelines;
5. Ballast water; and,
6. Once through non-contact cooling water

VI. Specific Permit Conditions

Conditions in the proposed permit are based on: (A) NSPS for New Source facilities; (B) BCT to control conventional pollutants; (C) BAT to control toxic and nonconventional pollutants; and (D) Ocean Discharge Criteria (CWA section 403(c)). Discussions of the rationale for the specific effluent limitations for each regulated waste stream appear below.

A. Drilling Fluids

The limitations in the expiring permit are based on a combination of National Effluent Limitations Guidelines and Ocean Discharge Criteria. The previous permit's limitations are proposed to be included in the reissued permit without any changes.

1. NSPS, BAT, and BCT

Offshore subcategory guidelines for NSPS (40 CFR 435.15) and BAT (40 CFR 435.13) for drilling fluids discharges from facilities located farther than 3 nautical miles from shore (from the inner boundary of the territorial seas), require no discharge of free oil, no discharge of diesel oil, and a minimum toxicity limit of 3% by volume. In addition, the effluent limitations guidelines prohibit the discharge of non-aqueous based drilling fluids except those adhering to drill cuttings and some small volume discharges. Free oil, for drilling fluids discharges, is measured using the static sheen test method. Toxicity is measured with a 96 hour LC50 on the suspended particulate phase using the *Mysidopsis bahia* species. Based on the guidelines, cadmium and mercury in stock barite used in drilling fluids are limited to 3 mg/kg dry weight and 1 mg/kg dry weight, respectively.

In addition to those effluent limitations guidelines based limits, the reissued permit is proposed to retain the prohibitions of the discharge of oil-based drilling fluids, inverse emulsion drilling fluids, oil contaminated drilling fluids, and drilling fluids to which mineral oil has been added. These prohibitions were included in the permit to ensure compliance with the no discharge of free oil BAT and NSPS limitations. An exception to those prohibitions is allowed in the expiring permit for drilling fluids to which mineral oil or non-aqueous based fluids have been added as a carrier agent, lubricity additive, or pill.

2. Requirements Based on Ocean Discharge Criteria (CWA section 403(c))

The expiring permit contains discharge rate limitations for drilling fluids which ensure discharged drilling fluids are sufficiently dispersed to prevent unreasonable degradation of the marine environment. Those limitations are proposed to remain in the reissued permit.

B. Drill Cuttings

1. All Drill Cuttings

The main source of pollutants in discharged drill cuttings is generally from the drilling fluids which were used in the well. Therefore, based on BAT, BCT, and NSPS, drill cuttings which are authorized to discharge by the general permit must all meet the same limitations and

prohibitions as drilling fluids. The discharge of drill cuttings generated using drilling fluids which are oil contaminated or contain diesel oil or mineral oil is prohibited. Cadmium and mercury, as measured in barite used in the drilling fluid, is limited to 3 mg/kg and 1 mg/kg, respectively. Also, the toxicity of the suspended particulate phase of the drilling fluids is limited to 30,000 ppm. Drill cuttings discharges are limited to no free oil, as measured using the static sheen test. These limitations are included in the expiring permit and are not proposed to be revised in the reissued permit.

2. Drill Cuttings Generated Using Non-Aqueous Based Drilling Fluids

The expiring permit was modified on December 18, 2001 (66 FR 65209), to authorize the discharge of drill cuttings generated by use of non-aqueous based drilling fluids. The limitations included in the permit were based on the Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards for the Oil and Gas Extraction Point Source Category, which was published in the Federal Register on January 22, 2001 (see 66 FR 6850). The new limits were included in the permit for both the stock base fluids and those drilling fluids which adhere to discharged drill cuttings. Limitations on the stock base fluid include polynuclear aromatic hydrocarbons (PAH), sediment toxicity (10-day), and biodegradation rate. Prior to its use, the drilling fluid is also limited for formation oil contamination, measured using Gas Chromatography/Mass Spectrometry (GC/MS). Drilling fluids which adhere to discharged drill cuttings are limited for sediment toxicity (4-day), formation oil contamination as measured by either a reverse phase extraction test or GC/MS, and base fluids which are retained on discharged drill cuttings. No changes to those limits are proposed.

C. Produced Water

1. NSPS and BAT

The Offshore Subcategory guidelines for NSPS (40 CFR 435.15) and BAT (40 CFR 435.13) require Oil and Grease limits of 29 mg/l, monthly average, and 42 mg/l, daily maximum. Those limitations are contained in the expiring permit and are included in the proposed permit.

2. Ocean Discharge Criteria (CWA Section 403(c))

Limits for whole effluent toxicity are contained in the expiring permit based on Ocean Discharge Criteria (CWA section 403(c)). No changes to those limits are proposed as a part of this reissuance. The dispersion modeling used to develop the toxicity limits was examined at length during the last permit reissuance and is deemed appropriate.

D. Produced Sand

1. NSPS, BAT and BCT

The expiring permit prohibited the discharge of produced sand based on NSPS, BAT, and BCT, established by the Offshore Subcategory Effluent Limitations Guidelines. That prohibition is not proposed to be change.

E. Well Treatment, Completion and Workover Fluids

1. NSPS, BAT, and BCT

The Offshore Subcategory guidelines for NSPS and BAT require Oil and Grease limits of 29 mg/l, monthly average, and 42 mg/l, daily maximum, for well treatment, completion and workover fluids. A limit of no free oil was also established by the guidelines based on BCT. Those limits were contained in the expiring permit and are not proposed to be changed.

2. Ocean Discharge Criteria (CWA section 403(c))

Discharged well treatment, completion, and workover fluids are proposed to be limited to no free oil as measured using the static sheen test method and no priority pollutants except in trace amounts. If materials added downhole as well treatment, completion, and workover fluids do not contain priority pollutants then the discharge is assumed to contain no priority pollutants, except in trace amounts. The no free oil limit will help prevent the discharge of toxic pollutants contained in oil, which may contaminate these fluids and cause unreasonable degradation of the marine environment. The limit of no priority pollutants except in trace amounts will help prevent the discharge of fluids containing toxic pollutants which have the potential to cause unreasonable degradation of the marine environment. Both of these limits were included in the expiring permit based on Ocean Discharge Criteria under CWA section 403(c).

F. Deck Drainage

1. NSPS, BAT and BCT

The expiring permit's limits are based on the Offshore Subcategory NSPS, BAT and BCT guidelines which all require No Discharge of Free Oil as determined by the presence of a film or sheen upon, or a discoloration of, the surface of the receiving water (visual sheen). No changes to those limits are proposed.

G. Sanitary Waste

1. NSPS and BCT

For sanitary waste, the Offshore Subcategory NSPS and BCT guidelines require residual chlorine to be a minimum of 1 mg/l and maintained as close to 1 mg/l as possible for offshore facilities continuously manned by ten or more persons. Also, the NSPS and BCT guidelines require No Discharge of floating solids for offshore facilities continuously manned by nine or fewer persons or intermittently manned by any number of persons. The expiring and proposed permits contain limits for sanitary wastewater which are based on those guidelines.

H. Domestic Waste

1. NSPS, BAT and BCT

The expiring and proposed permits' limits for domestic waste are based on the Offshore Subcategory NSPS, BAT and BCT established by the Effluent Limitations Guidelines. The guidelines require no floating solids or foam and require compliance with the requirements of 33

CFR 151.

I. Miscellaneous Discharges

1. BCT

The expiring permit's requirements of No Free Oil as monitored by the Visual Sheen Test and no floating solids or foam are based on BCT using Best Professional Judgement (BPJ) and are proposed to be continued in the reissued permit. These miscellaneous discharges are not addressed in the Offshore Subcategory guidelines. In addition, the miscellaneous discharges of chemically treated sea water and fresh water are limited for the concentration of treatment chemicals used based on BAT using BPJ and for whole effluent toxicity based on 403(c).

J. All Discharges

For all permitted discharges, the expiring permit requires no discharge of halogenated phenols based on CWA section 403(c), No Discharge of rubbish, trash and other refuse based on the International Convention for the Prevention of Ships (MARPOL), no discharge in areas of biological concern based on CWA section 403(c) and the minimization of discharge of surfactants, dispersants and detergents based on CWA section 403(c). These requirements are not proposed to be changed.

VII. Produced Water Study for the Northern Gulf of Mexico

A. Causes and Effects of the Northern Gulf of Mexico Hypoxia

The hypoxic zone of the Gulf of Mexico has long been degraded due to low concentrations of dissolved oxygen. Hypoxic conditions are believed to be caused mainly by high concentrations of nutrients in the Mississippi River's discharge into the Gulf of Mexico. The hypoxic zone has been found to be generally increasing in size and has covered an area of up to 18,000 km², extending westward from the Mississippi River delta and at times reaching waters offshore of Texas. The Mississippi River's high nutrient load into the Gulf is contained in the upper, less saline, portion of the water column. The total nutrient loading is approximately 1,567,900 metric tons of total nitrogen per year (CENR, 2000). As a result of that nutrient enrichment, a highly elevated level of biological productivity occurs in the upper water column. Carbonaceous matter settles from that highly productive upper layer and, through the process of decaying, consumes the available dissolved oxygen in the lower water column, resulting in the hypoxia. During the last century, accumulation of organic carbon in the Northern Gulf of Mexico has increased from approximately 2 mg per square centimeter per year to nearly 10 mg per square centimeter per year. The hypoxic waters occur from shallow (4 to 5 meters) near shore waters to deeper waters (up to 60 meters) and typically encompass the lower one half to two thirds of the water column (CENR, 2000).

The consequences of hypoxia are not fully known. However, the shallow continental shelf area in the Gulf of Mexico that is affected by hypoxia shows signs of hypoxia-related stress;

i.e., low abundance of fish and shrimp and distinctly different benthic communities. While current ecological conditions are a response to a variety of stressors, the most obvious effects of hypoxia are that many bottom-dwelling (benthic) organisms die, larger, long-lived species are eliminated, and productivity is shifted to non-hypoxic periods (energy pulsing). Effects of hypoxia on fishery resources could include direct mortality of both fish and their food base, as well as such indirect effects as altered migration patterns, reduction in suitable habitats, increased susceptibility to predation and disease, and disruption of spawning and recruitment (CENR, 2000).

B. Produced Water Discharges to the Hypoxic Zone

Produced water is defined as the water (brine) brought up from the hydrocarbon bearing strata during extraction of oil and/or gas and can include formation water, injection water, small volumes of condensed water, and trace amount of treatment chemicals. Produced water is the highest volume waste generated in association with oil and gas production operations. (CAPP, 2001) The waste stream can contain oxygen demanding pollutants and nutrients, which could contribute to the hypoxia if discharged in sufficient quantities.

At the time the current permit was developed and reissued in 2004, EPA was concerned that the potential impacts of produced water discharges to the hypoxic zone were not well understood. Although there were known to be a fairly large number of produced water discharges made to the hypoxic zone, neither the volume of those discharges nor the concentration of pollutants they contained were accurately characterized. EPA determined that there was an important need to gather data regarding the pollutant load from produced water discharged to the hypoxic zone and examine whether that loading has the potential to impact the hypoxia.

C. Study on the Impact of Produced Water on the Hypoxic Zone of the northern Gulf of Mexico

That study was done as a cooperative effort between EPA, Minerals Management Service, the Department of Energy, and industry. As required by the current permit, industry determined the number and volume of produced water discharges to the hypoxic zone. In the characterization portion of the study, produced water samples were collected from a representative number of platforms and analyzed for pollutants which have the potential to impact the hypoxia. Three existing models were used to examine the resulting produced water data and determine whether the discharges have the potential to contribute to hypoxia.

Approximately 250 platforms discharge produced water to the hypoxic zone. 50 of those platforms were selected for sampling. Of those 50 platforms, 16 were sampled three times in an effort to characterize the variability of pollutant concentrations. 34 additional platforms were sampled once. The results of the produced water characterization portion of the study are shown

below in Table 1. Pollutant loading to the hypoxic zone is shown in Table 2 for the 50 sampled platforms and is estimated for all produced water discharges in that area.

Table 1: Produced Water Analytical Data (Veil et. al., 2005)

Parameter	Mean	Median	Maximum	Minimum
Biochemical Oxygen Demand (BOD) (mg/l)	957	583	11,108	80
Dissolved BOD (mg/l)	498	432	1,128	132
Suspended BOD (mg/l)	76	57	146	16
Total Organic Carbon (TOC) (mg/l)	564	261	4,880	26
Dissolved TOC (mg/l)	216	147	620	67
Suspended TOC (mg/l)	32	13	127	5
Nitrate (mg/l)	2.15	1.15	15.80	0.60
Nitrite (mg/l)	0.05	0.05	0.06	0.05
Ammonia (mg/l)	74	74	246	14
Total Kjeldhal Nitrogen (TKN) (mg/l)	83	81	216	17
Orthophosphate (mg/l)	0.43	0.14	6.60	0.10
Total Phosphorous (mg/l)	0.71	0.28	7.90	0.10
Conductivity (umhos/cm)	87,452	86,480	165,000	360
Salinity (ppt)	100	84	251	0
Temperature (°C)	38	32	80	20
pH (SU)	6.29	6.50	7.25	1.77

Table 2: Produced Water Loading Estimates for 50 Sampled Platforms and the Entire Hypoxic Zone (Veil et. al., 2005)

Parameter	Loading from Sampled Platforms (lbs/day)	Estimated Loading for Entire Hypoxic Zone (lbs/day)
BOD	36,000	104,000
TOC	14,100	40,700
Nitrate	68.3	197
Nitrite	3.07	9
Ammonia	4,770	13,800
TKN	5,140	14,900
Orthophosphate	22.6	65
Total Phosphorous	37.6	109

Existing hypoxia models, developed by Bierman, et. al. (1994), Justic et. al. (1996, 2002), and Scavia et. al. (2003), were used to analyze the potential incremental impacts to the hypoxia from produced water discharges. These three models were chosen because they are peer reviewed and examine different attributes of the hypoxia. The Bierman model simulates three dimensional food-web-nutrient-oxygen dynamics for a 21-segment spatial grid covering the hypoxic zone. The Justic model simulates time dependent oxygen dynamics for a single location, driven by meteorological conditions and nitrogen loads. The Scavia model simulates nutrient-dependent production, respiration of organic matter, and the resulting oxygen balance. The Bierman and Justic models calculate the bottom water dissolved oxygen concentration; whereas, the Scavia model analyzes the potential for incremental changes in the hypoxic area.

The model results all showed a potential for produced water to contribute to hypoxia; however, that contribution is very small and within the margin of uncertainty for both the models and the produced water pollutant data. The Scavia model predicted an average increase in the size of the hypoxic zone of 4.5 percent, but that increase was only predicted in 3 of the 18 years examined. There was no increase in the hypoxic area predicted for the other 15 years. The Bierman and Justic models both predicted a slight decrease in the bottom water dissolved oxygen concentration as a result of produced water discharges; however, that decrease was very small. The Bierman model predicted a decrease in the dissolved oxygen concentration ranging from 0.11 to 0.143 percent. Likewise, the Justic model predicted a decrease of 0.0023 percent in the bottom water dissolved oxygen concentration.

Based on the results of the study, EPA finds that the potential impact on the hypoxia from

produced water discharges is insignificant. Therefore, no additional permit requirements are proposed at this time.

VIII. Changes from the Expiring Permit

A. Cooling Water Intake Requirements - 316(b) Phase III

Recently issued regulations require that new offshore oil and gas facilities take measures to reduce entrainment and impingement of aquatic life. The 316(b) Phase III regulation applies to new facilities which intake 2 million gallons per day of water and use at least 25 percent for cooling. The facilities which are affected by these new requirements are new facilities for which construction is commenced after July 17, 2006. In general, the regulations require operators to submit information demonstrating that new 316(b) Phase III facilities will be designed so that the water intake velocity is less than 0.5 feet per second and other measures such as screens are employed to reduced entrainment when feasible. These new requirements are proposed to be included in the reissued permit. The application requirements are proposed to be required to be submitted as a part of the notice of intent to be covered by the general permit.

The 316(b) Phase III regulations also require baseline and periodic biological monitoring. Baseline monitoring is required to characterize the biological community which could be impacted by the intake of cooling water. Periodic monitoring is intended to measure the number organisms and types of species entrained in the system. As proposed, the permit will require new 316(b) Phase III facilities to conduct this biological monitoring. The permit is also proposed to give operators the option of participating in an EPA approved industry-wide study to fulfill these monitoring requirements. Such a study will need to include sufficient detail such that EPA can determine that intake structure designs are sufficient to minimize impacts due to entrainment and impingement and that no additional measures are warranted.

B. Use of Sub-lethal Effects in Whole Effluent Toxicity Compliance

In 1995, Region 6 made a commitment to EPA Headquarters to fully implement the requirements of 40 CFR 122.44.(d)(1). That implementation includes requirements for sub-lethal effects monitoring and compliance in whole effluent toxicity testing. EPA Region 6 is currently requiring the use of sub-lethal effects in whole effluent toxicity testing for NPDES permits. Those requirements are proposed to be included in the reissued general permit. Since this change will result in more stringent whole effluent toxicity limits for produced water discharges, a compliance schedule has been included in the permit. Permittees will be granted a two year period to come into compliance with the more stringent limits.

C. Clarification of Types of Activities Covered

Changes are included in the proposed permit to clarify that certain types of non-oil and gas producing facilities are included in its coverage. Platforms which serve as pipeline facilities,

discharge waste streams such as deck drainage and sanitary waste water, which are presently authorized by the permit. Since those types of discharges are already authorized and will be identical at a pipeline facility to those made from an oil and gas extraction facility, EPA has determined that it is most appropriate to cover these facilities under this general permit. In addition, clarification has been included in the proposed permit regarding discharges associated with platform installation and decommissioning. Any discharge associated with facility installation or decommissioning has previously been considered and is presently authorized by the permit. Therefore, the permit more clearly states that these activities are included as operations which are covered. Since EPA has previously authorized discharges from all of these types of facilities, these changes simply provide clarification and do not expand the operations covered under the permit.

D. Discharges Associated with Pit Cleaning and Other Wash Water

Clarification is proposed to be added to the permit regarding discharges of waste water used for cleaning drilling fluids from pits or washing deck areas coated with drilling fluids. In general, EPA believes that these discharges most closely represent the original waste stream. Drilling fluid which is being cleaned from a pit will not differ significantly from the original drilling fluid the pit held. Therefore, the permit's drilling fluids limits will still apply to pit cleaning discharges.

Drilling fluid which has deposited on deck surfaces presents a safety concern due to its slickness and is not allowed to accumulate in significant amounts. Thus, when the deck is being washed, a smaller quantity of drilling fluid will be present on the deck surface and it will be much more dilute in the deck washing discharge than in a pit cleaning discharge. Therefore, deck wash water is not proposed to be treated as a drilling fluid discharge. Instead, the permit's deck drainage limits are required. This issue is addressed by the current permit's deck drainage definition which includes deck washings. This change does not expand the scope of the permit but simply clarifies the existing requirements.

E. Discharge of Wastes from Surface Preparation or Coating

Regulations at 33 CFR 151 and the current permit prohibit the discharge of garbage. Under the regulations, garbage is defined to include maintenance waste. This prohibition has led to confusion regarding the level of effort required to capture maintenance waste associated with sandblasting and other types of surface preparation and painting, or coating, of the prepared surface. When performing operations such as sand blasting, operators typically utilize tarps or other means to capture as much waste material as practicable. It is, however, not possible to capture all waste materials when conducting these operations without creating a safety risk for personnel. To resolve this issue, new language included in the proposed permit requires operators to capture as much waste as practicable. The discharge of that collected waste is prohibited. The discharge of fugitive material, such as wind blown sand or paint spray, is not included in that discharge prohibition if operators take all steps practicable to capture waste material. EPA previously sent the Offshore Operators Committee a letter clarifying this issue

and now proposes to include the requirements in the permit so that they are more widely available. Since this change only clarifies the requirement that operators capture as much waste as practicable and does not authorize the discharge of any new waste stream, the scope of the permit is not expanded as a result of this clarification.

F. End-of-Well Monitoring for Non-Aqueous Based Drilling Fluids

Industry representatives have requested that the permit's requirements for end-of-well drilling fluid samples be clarified to show whether the requirement applies to internal olefin based fluids. As requested, a clarification is included in the proposed permit. An end-of-well sample for toxicity testing is required for internal olefin based drilling fluids. The end-of-well sample will measure the toxic effects of the drilling fluid after all components have been added and is expected to demonstrate whether the drilling fluid complies with the toxicity limit in worst case conditions.

G. Sediment Toxicity and Biodegradation Test Averaging

EPA sent industry a letter on October 20, 2004, which sets forth how sample averaging can be utilized to meet the permit's sediment toxicity and biodegradation limits. That clarification is included in the proposed permit. EPA Region 4 also included this language in the last issuance of the General Permit for Oil and Gas Activities in the Eastern Gulf of Mexico. As proposed and previously clarified by letter, operators are allowed to collect two samples of drilling fluid for testing. One of those samples would be split and tested separately. The second sample would be preserved and tested later if needed. Operators would then be authorized to average the results of up to all three samples to determine compliance with the toxicity limit. The averaging allowance is proposed to be included in the permit to resolve issues with potential test variability which have been raised.

H. Drilling Fluid Discharge Rate Limitation

Industry representatives have asked for clarification on the applicability of the drilling fluid discharge rate limitation to non-aqueous based drilling fluids. In response to that request the proposed permit states that the rate limit does not apply to non-aqueous based drilling fluids. The discharge rate limit is included in the permit to require that bulk discharge of drilling fluids is done in a controlled manner at the end of drilling. Since, unlike water based fluids, non-aqueous based drilling fluids are not discharged in bulk at the end of drilling, the discharge rate limitation is not relevant.

I. Application of Free Oil limits Prior to Installation of Marine Risers

The current permit contains an exemption from the drilling fluid discharge rate limit prior to installation of the marine riser. This exemption was included in the permit because no drilling fluid is circulated prior to installation of the riser and operators have no way to control or measure the amount of sediment on the sea floor which is disturbed during the initial stages of

drilling. Likewise, if shallow pockets of oil are encountered in the unconsolidated sediments on the sea floor, operators have no way of preventing that oil from being released into the water column prior to installation of the marine riser. Therefore, a change is included in the proposed permit to show that the drilling fluid free oil limits do not apply prior to installation of the marine riser.

J. Discharges Associated with Dual Gradient Drilling

The current permit authorizes the discharge of a portion of drilling fluids and drill cuttings at the sea floor when dual gradient drilling is conducted. The definition of dual gradient drilling is proposed to be changed to show that the discharges are not limited to the sea floor but can be made at any level in the water column. This change will allow greater flexibility in locating sub-sea drilling fluid pumps for deep water operations and does not affect any permit limit. Drilling fluids and drill cuttings discharges which are made higher in the water column will be more dispersed than those made at the sea floor and will be less likely to result in cuttings piles.

K. Toxicity Testing Requirements for Miscellaneous Discharges

Industry representatives requested clarification on whether toxicity testing is required when free chlorine is produced using an electrical current rather than being added to miscellaneous discharges. Toxicity testing is required when treatment chemicals are used to treat seawater or freshwater to prevent corrosion or fouling. The purpose for generating chlorine using an electrical current is to produce a biocide which will prevent fouling of equipment or piping. Biocides are included in the permit's definition of treatment chemicals for which toxicity testing is required. Therefore chlorine generated using an electrical current is not exempt from the testing requirements. The permit's definition is proposed to be changed to show that toxicity testing is required.

L. Produced Water Oil and Grease Sampling

A change is proposed in the permit's produced water monitoring requirements to address discharges which are temporarily ceased. The permit presently requires operators to sample produced water discharges for compliance with the oil and grease limit within two hours after observing a sheen on the surface water. However, if operators cease discharge in order to repair equipment, monitoring may not be possible within two hours after sighting a sheen. Therefore, the monitoring requirement is proposed to be changed to state that a sample must be collected within two hours of seeing a sheen or within two hours after startup of the system if it is shut down immediately following discovery of a sheen.

M. Calculation of Produced Water Critical Dilution

A clarification is proposed in the permit's requirements for determining the critical dilution for produced water toxicity testing. The permit presently does not address cases where a

platform has been shut in and restarts or where ownership changes. Currently, the permit requires that operators use the discharge rate reported on the most recent discharge monitoring report for determining the critical dilution for toxicity testing. For new discharges, the current permit requires operators to determine the critical dilution based on the highest monthly average discharge rate during the previous three months. That allowance for new discharges is proposed to also be applied to discharges which have been shut in and restarted and to changes of ownership. In both those cases, the discharge rate previously reported on the discharge monitoring report may not be representative of current operations. The highest discharge rate from the previous three months is deemed to be more representative.

N. Measurement of Cadmium and Mercury in Stock Barite

Permittees are required to use EPA approved test methods listed in 40 CFR Part 136, unless alternate approval has been obtained for using alternate test methods. Since the test methods specified in 40 CFR Part 136 are for use in water and barite is a solid, alternate test methods were included in the current permit for measurement of cadmium and mercury. EPA methods 245.5 and 7471 were determined to be appropriate for the measurement of cadmium and mercury in stock barite when the permit was issued and were included as alternate test methods. Those test methods have been updated and improved since that time and permittees have been granted approval for using those more current test methods. Therefore, the additional alternative test methods are included in the permit for use in monitoring compliance with the limits for cadmium and mercury in stock barite.

O. Previous Study Requirements

The current permit includes residual requirements for two different studies which have been completed. Those studies are the Produced Water Hypoxia Study and the Non-Aqueous Based Drilling Fluid Seabed Survey. Both studies have been completed; therefore, the requirements are proposed to be removed from the permit.

IX. References

Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico, Mississippi River/Gulf of Mexico Nutrient Task Force, January, 2001.

America's Living Oceans, Charting a Course for Sea Change, Summary Report, PEW Oceans Commissions, May, 2003.

Argonne National Laboratory. 2004 January. *A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas, and Coal Bed Methane*, prepared for Department of Energy. <http://www.ead.anl.gov/pub/doc/ProducedWatersWP0401.pdf>

Boornazian, Linda Y., and Mary T. Smith, "Clarification of Technology-based Sediment

Toxicity and Biodegradation Limitations and Standards for Controlling Synthetic-based Drilling Fluid Discharges”, Memorandum from EPA Water Permits Division and Engineering and Analysis Division to Miguel Flores, Director, EPA Region 6 Water Quality Protection Division, October 10, 2003.

Canadian Association of Petroleum Producers, *Produced Water Waste Management, Technical Report 2001-0030*, August 2001.

CENR, *An Integrated Assessment of Hypoxia in the Northern Gulf of Mexico*, Committee on Environment and Natural Resources of the National Science and Technology Council, May, 2000.

Development Document for Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category, USEPA, Office of Water, EPA-821-R-96-023, October, 1996.

Development Document for Interim Final Effluent Limitations Guidelines and Proposed New Source Performance Standards for the Oil and Gas Extraction Point Source Category, EPA 440/1-76/055-a, United States Environmental Protection Agency, September, 1976

Final NPDES General Permit for New and Existing Sources in the Offshore Subcategory of the Oil and Gas Extraction Category for the Western Portion of the Outer Continental Shelf of the Gulf of Mexico (GMG290000) 69 FR 60150, October 7, 2004.

Final NPDES General Permit for New and Existing Sources in the Offshore Subcategory of the Oil and Gas Extraction Category for the Western Portion of the Outer Continental Shelf of the Gulf of Mexico (GMG290000) 61 FR 41609, August 9, 1996.

Final Report, Gulf of Mexico Comprehensive Synthetic Based Muds Monitoring Program, Continental Shelf Associates, October, 2004.

Hill, Troy C., EPA, Letter to Kent Satterlie, Offshore Operators Committee, Addressing surface preparation and coating, April 18, 2005.

Hill, Troy C., EPA, Letter to Kent Satterlie, Offshore Operators Committee, Addressing averaging test results for sediment toxicity and biodegradation testing, October 20, 2004.

Minerals Management Service. 2002 November. *Final Environmental Impact Statement, Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007*

Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms. (1991). EPA 600/4-90/027, U.S. Environmental Protection Agency, September.

Neff, J.M., *Fate and Effects of Mercury from Oil and Gas Exploration and Production*

Operations in the Marine Environment. Battelle Memorial Institute, July, 2002.

Neff, J., T. Sauer, Jr., N. Maciolek, *Composition, Fate and Effects of Produced Water Discharges to Nearshore Marine Waters*, Produced Water, Edited by J. Ray and F. Engelhart, Plenum Press, New York, 1992.

Ocean Discharge Criteria Evaluation for the NPDES General Permit for the Western Gulf of Mexico OCS. (1992). Avanti Corp., Vienna, Virginia, June.

Oil and Gas Extraction Point Source Category Effluent Limitations Guidelines and New Source Performance Standards. (1993). EPA, 40 CFR Part 435, March 4, (58 FR 12454).

OSPAR, *Background Document Concerning Techniques for the Management of Produced Water from Offshore Installations*, OSPAR Commission, 2002.

Predicted Impacts from Offshore Produced Water Discharges on Hypoxia in the Gulf of Mexico, Limno-Tech, Inc., June, 2006.

Rabalais, N., R.E. Turner, D. Justic, Q. Dortch, and W. Wiseman Jr., *Flux and Sources of Nutrients in the Mississippi-Atchafalaya River Basin, Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico*. NOAA Coastal Ocean Program, U.S. Department of Commerce. May, 1999.

Rabalais, N., R.E. Turner, D. Justic, Q. Dortch, and W. Wiseman Jr., *Charaterization of Hypoxia, Topic 1 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico*, NOAA Coastal Ocean Program, U.S. Department of Commerce, May, 1999.

Rabalais, N., B. McKee, D. Reed, and J Means, *Fate and Effects of Produced Water Discharges in Coastal Louisiana, Gulf of Mexico, USA*, Produced Water, Edited by J. Ray and F. Engelhart, Plenum Press, New York, 1992.

Rabalais, N., R.E. Turner, and W. Wiseman Jr. 1992. *Distribution and characteristics of hypoxia on the Louisiana shelf in 1990 and 1991*. In Proceeding, nutrient enhanced coastal ocean productivity workshop, 15-20. Publication no. TAMU-SG-92-109. College Station, TX: Texas A&M University, Texas Sea Grant College Program.

Raimond, P., A Barnet, and P. Krause, *The Effects of drilling Muds and Marine Invertebrate Larvae and Adults*, Environmental Toxicology and Chemistry, vol. 16, no. 6, pp. 1218-1228,, June, 1997.

Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. (1988). EPA 600/4-87/028, U.S. Environmental Protection Agency, May.

Stephenson, M., *A Survey of Produced Water Studies*, Produced Water, Edited by J. Ray and F. Engelhart, Plenum Press, New York, 1992.

Stockton, David, EPA, Letter to James Robinson, BP Americas, Inc., Approving alternate test methods, July 28, 2006.

Technical Support Document for Water Quality-based Toxics Control. (1991). EPA/505/2-90-001, PB91-127415, U.S. Environmental Protection Agency, March.

Veil, J., T. Kimmel, and A. Rechner, *Characteristics of Produced Water Discharged to the Gulf of Mexico Hypoxic Zone*, Department of Energy, August, 2005.